In the Claims:

A complete listing of the claims is set forth below. This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims

1. (Currently amended) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and

wherein a crystal structure of the seed layer is a face-centered cubic structure and substantially a single phase, and wherein a body-centered cubic structure is substantially not present.

2. (Original) An exchange coupled film according to Claim 1, wherein the Cr content is 40 to 60 atomic percent, and the thickness of the seed layer is 10 to 170 Å.

3. (Original) An exchange coupled film according to Claim 1, wherein the Cr content is 45 to 60 atomic percent, and the thickness of the seed layer is 10 to 130 Å.

4. (Original) An exchange coupled film according to Claim 1, wherein the Cr content is 40 to 50 atomic percent, and the thickness of the seed layer is 10 to 170 Å.

5. (Original) An exchange coupled film according to Claim 1, wherein the Cr content is 45 to 55 atomic percent, and the thickness of the seed layer is 10 to 130 Å.

6. (Previously presented) An exchange coupled film according to Claim 1, wherein the thickness of the seed layer is at most 80 Å.

7. (Previously presented) An exchange coupled film according to Claim 1, wherein the thickness of the seed layer is at most 60 Å.

8. (Original) An exchange coupled film according to Claim 1, wherein the seed layer comprises one of a NiFeCr alloy and a NiCr alloy.

9. (Previously presented) An exchange coupled film according to Claim 8, wherein the seed layer has a composition represented by $(Ni_{100-x}Fe_x)$-Cr, and an atomic ratio x satisfies the relationship $0 \leq x \leq 70$.

10. (Original) An exchange coupled film according to Claim 9, wherein the atomic ratio x satisfies the relationship $0 \leq x \leq 50$.

11. (Original) An exchange coupled film according to Claim 10, wherein the atomic ratio x satisfies the relationship $0 \leq x \leq 30$.

12. (Original) An exchange coupled film according to Claim 1, further comprising an underlayer formed under the seed layer, the underlayer comprising at least one element selected from the group consisting of Ta, Hf, Nb, Zr, Ti, Mo, and W.

13. (Original) An exchange coupled film according to Claim 1, wherein the seed layer is formed by sputtering.

14. (Previously presented) An exchange coupled film according to Claim 1, wherein an average crystal grain size in a direction parallel to a layer surface in each layer formed on the seed layer is at least 100 Å.

15. (Previously presented) An exchange coupled film according to Claim 14, wherein the average crystal grain size is at least 150 Å.

16. (Previously presented) An exchange coupled film according to Claim 14, wherein the average crystal grain size is at least 170 Å.

17. (Previously presented) An exchange coupled film according to Claim 1, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

18. (Previously presented) An exchange coupled film according to Claim 1, wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the seed layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at an interface between the antiferromagnetic layer and the seed layer.

19. (Original) An exchange coupled film according to Claim 1, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the ferromagnetic layer, and at least some of the equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer.

20. (Original) An exchange coupled film according to Claim 1, wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the seed layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the seed layer, and at least some of the equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer.

21. (Original) An exchange coupled film according to Claim 1, wherein the antiferromagnetic layer comprises X and Mn, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os.

22. (Original) An exchange coupled film according to Claim 1, wherein the antiferromagnetic layer comprises an X-Mn-X' alloy, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os and X' is at least one element selected from the group consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Ir, Sn, Hf, Ta, W, Re, Au, Pb, and rare-earth elements.

23. (Previously presented) An exchange coupled film according to Claim 22, wherein the X-Mn-X' alloy is one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn and a substitutional solid solution in which atoms of X' are substituted for some atoms at lattice points of a crystal lattice comprising X and Mn.

24. (Previously presented) An exchange coupled film according to Claim 21, wherein a X content is 45 to 60 atomic percent.

25. (Previously presented) An exchange coupled film according to Claim 22, wherein a X + X' content is 45 to 60 atomic percent.

26-76 (Canceled)

77. (Canceled)

78. (Previously presented) An exchange coupled film according to Claim 1, wherein the antiferromagnetic layer comprises an X-Mn-X' alloy, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os and X' is at least one element selected from the group consisting of Ne, Ar, Kr, and Xe.

79. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure, and

wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the ferromagnetic layer which appear in a cross section of the exchange coupled film parallel to a thickness direction are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer.

80. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure, and

wherein grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the seed layer which appear in a cross section of the exchange

coupled film parallel to a thickness direction are at least partially discontinuous at an interface between the antiferromagnetic layer and the seed layer.

81. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure, and

wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the ferromagnetic layer, and at least some of the equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer.

82. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field

produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure, and

wherein equivalent crystal planes represented as {111} planes in the antiferromagnetic layer and the seed layer are preferentially oriented as crystal planes parallel to the interface between the antiferromagnetic layer and the seed layer, and at least some of the equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer.

83. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure,

wherein the antiferromagnetic layer comprises an X-Mn-X' alloy, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os and X' is at least one element selected from the group consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Ir, Sn, Hf, Ta, W, Re, Au, Pb, and rare-earth elements, and

wherein the X-Mn-X' alloy is one of an interstitial solid solution in which atoms of X' enter interstices in a space lattice comprising X and Mn and a substitutional solid solution in which atoms of X' are substituted for some atoms at lattice points of a crystal lattice comprising X and Mn.

84. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure,

wherein the antiferromagnetic layer comprises X and Mn, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os, and wherein a X content is 45 to 60 atomic percent.

85. (New) An exchange coupled film comprising:

a nonmagnetic seed layer comprising α and Cr, α being at least one of Fe, Ni, and Co;

an antiferromagnetic layer; and

a ferromagnetic layer,

the seed layer, the antiferromagnetic layer, and the ferromagnetic layer being deposited in that order from the bottom, magnetization of the ferromagnetic layer being directed in a predetermined direction by an exchange coupling magnetic field

produced at an interface between the antiferromagnetic layer and the ferromagnetic layer,

wherein a Cr content of the seed layer is 35 to 60 atomic percent, a thickness of the seed layer is 10 to 200 Å, and a crystal structure of the seed layer is a face-centered cubic structure,

wherein the antiferromagnetic layer comprises an X-Mn-X' alloy, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os and X' is at least one element selected from the group consisting of Ne, Ar, Kr, Xe, Be, B, C, N, Mg, Al, Si, P, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ag, Cd, Ir, Sn, Hf, Ta, W, Re, Au, Pb, and rare-earth elements, and wherein a X + X' content is 45 to 60 atomic percent.